

REMARKS

The present invention relates to a lithium-cobalt composite oxide for a lithium secondary cell, a process for its production, a positive electrode for a lithium secondary cell employing it, and a lithium secondary cell.

As described in the specification under "Background Art," beginning at page 1, line 11, lithium secondary cells employing a lithium-cobalt composite oxide (LiCoO_2) as a positive electrode active material, are known. Also known are such composite oxides wherein some amount of cobalt has been replaced with another element. Various processes for making such lithium-cobalt composite oxides are also known. One such process, as described in the specification at page 2, lines 6-12, and as disclosed in JP-A-10-1316 (Aoki et al), uses an active material LiCoO_2 which is obtained by dispersing in an aqueous lithium hydroxide solution, e.g., cobalt hydroxide or cobalt oxyhydroxide wherein the valence of cobalt is trivalent, followed by heat treatment, for the purpose of improving the cycle characteristics, etc., of a lithium secondary cell. Applicants further describe, at page 3, lines 10-17 of the specification, after discussing the prior art, that no product has been known which fully satisfies all of the requirements for cycle characteristics, the initial weight capacity density, the stability and the low temperature operation efficiency, and for a production method for efficient mass production.

As recited in Claim 1, the present invention is a hexagonal lithium-cobalt composite oxide for a lithium secondary cell, which is represented by the formula $\text{LiCo}_{1-x}\text{M}_x\text{O}_2$, wherein x is $0 \leq x \leq 0.02$ and M is at least one member selected from the group consisting of Ta, Ti, Nb, Zr and Hf, and which has a half-width of the diffraction peak for (110) face at $2\theta=66.5\pm 1^\circ$, of from 0.070 to 0.180° , as measured by the X-ray diffraction using CuK_α as a ray source.

As recited in Claim 5, the present invention is also a process for producing the hexagonal lithium-cobalt composite oxide for a lithium secondary cell as defined in Claim 1, which comprises dry blending a cobalt oxyhydroxide powder having an average particle size of from 1 to 20 μm and a specific surface area of from 2 to 200 m^2/g , a lithium carbonate powder having an average particle size of from 1 to 50 μm and a specific surface area of from 0.1 to 10 m^2/g , and a powder of an oxide of metal element M having an average particle size of at most 10 μm and a specific surface area of from 1 to 100 m^2/g , and firing the mixture at a temperature of from 850 to 1,000°C in an oxygen-containing atmosphere.

The specification herein contains data showing that the value of "x" in $\text{LiCo}_{1-x}\text{M}_x\text{O}_2$ affects the half-width of the diffraction peak for (110) face at $2\theta=66.5\pm 1^\circ$. For example, Examples 15 and 16 each employ a value of x as 0.05, resulting in said half-width being higher than the presently-recited maximum of 0.180° , and also resulting in a capacity retention after 40 charge/discharge cycles, less than that of the corresponding example compared to, i.e., Examples 1 and 5, respectively. Thus, Example 1 had a value of x of 0.002, and a capacity retention after 40 charge/discharge cycles of 95.3%; that of Example 15 was 93.6%. Similarly, Example 5 had a value for x of 0.002, and a capacity retention of 95.8%; the capacity retention for Example 16 is 93.8%. In addition, the half-widths between Examples 1 and 15, and between Examples 5 and 16, respectively, differ.

In addition, each of Examples 12, 13 and 14 demonstrates how the change of a particular variable affects the results. Example 12 employs a cobalt oxide powder instead of cobalt oxyhydroxide as in Example 9. Example 13 employs a cobalt oxyhydroxide powder having a different average particle size and a different specific surface area compared to the cobalt oxyhydride powder used in Example 9. Example 14 employs a lower firing

temperature than that used in Example 9. In all of these Examples 12-14, both the half-width and the capacity retention changed.

The above-discussed results could not have been predicted by the applied prior art.

In addition, it is understood that in preparation of lithium cobaltate, the properties of lithium cobaltate and characteristics of cells to be produced substantially depend on the types of the starting materials, properties of the starting materials, mixing method (wet system or dry system), and firing (sintering) temperature and atmosphere.

The rejection of Claims 1, 2 and 5-11 under 35 U.S.C. § 102(b) as anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as obvious over, Aoki et al, is respectfully traversed. In addition to the discussion above with regard to Aoki et al, Aoki et al disclose a lithium-cobalt composite oxide having the formula $\text{LiCo}_{1-x}\text{A}_x\text{O}_y$, wherein x is between 0 and 0.25, and y is between 1.875 and 2.25. A can be, *inter alia*, Ti, Nb, Zr, Hf, and Ta. However, Aoki et al do not exemplify any lithium-cobalt composite oxides within the terms of the present claims, and moreover, do not recognize the effect the value of "x" has, both on the half-width and the capacity retention. In addition, the above-discussed data in the specification shows that how the lithium-cobalt composite oxide is made affects its physical properties and thus, affects the make-up of the composite oxide itself.

With regard to process Claims 5 and 6, the Examiner finds, at pages 8-9, as follows:

These intermediate constituents while having particular average particle size and specific surface area is not clearly and linearly applicable to the end product of claim 1. The product itself claims no particular particle size or specific surface area and the process steps of claims 5 and 6 manipulate the mixture of constituents of claim 5 to form the end product of claim 1. Thus while the intermediate constituents may have particular dimensions it is not held that these dimensions are linearly applicable to the end product.

Regarding the overall process of claims 5 and 6, the prior art fabricates the same product, as discussed above. The instant application has not established that the prior art product does not anticipate or obviate the product of claim 1. Since it is the Examiner's position, based on the prior art teachings

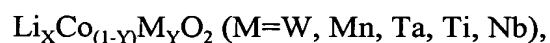
above, that the prior art product anticipates or is obvious over the product of claim 1, and there is no evidence that the process of claims 5 and 6 are critical in obtaining the product of the instant claims, the prior art is held to anticipate or render obvious the product by process limitations of claims 5 and 6.

It is respectfully submitted that the Examiner has incorrectly treated Claims 5 and 6, which are drawn to a process, even though couched as a process for making a particular product. Aoki et al neither disclose nor suggest the process of these claims for many reasons, including the lack of disclosure of a starting lithium carbonate powder or of firing at a temperature of from 850 to 1,000°C in an oxygen-containing atmosphere. Rather, Aoki et al disclose a lithium hydroxide solution as their lithium source [0009], and a heat treatment of 60-500°C [0033].

For all the above reasons, it is respectfully requested that the rejection over Aoki et al alone be withdrawn.

The rejection of Claims 1, 2, 5-7, 10 and 11 under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over, U.S. 5,147,738 (Toyoguchi), is respectfully traversed.

Toyoguchi discloses a cathode active material having the following formula:



which is prepared by mixing Li_2CO_3 , CoCO_3 and at least one oxide of W, Mn, Ta, Ti, Nb at predetermined ratio (Li atom = X mole, Co atom = 1-Y mole, M atom = Y mole), wherein $0.05 \leq Y \leq 0.35$, followed by heating the mixture at 900°C for 10 hours (column 1, lines 48-63 and column 2, lines 54-61). In each of Tables 1-5 therein, Toyoguchi exemplifies cathode active materials of the above formula wherein, *inter alia*, X is 1, and Y is 0.02 (which examples are thus outside the scope of Toyoguchi's invention). However, since Toyoguchi discloses preparing their cathode active material with starting materials different from the

present starting materials, and in view of the above-discussed comparative data, it would not be expected that the cathode active material of Toyoguchi would be the same as, or have the same properties as, the presently-claimed lithium-cobalt composite oxide. Note also that when Y is within the terms of Toyoguchi's invention, i.e., above 0.05, discharge capacity per unit weight tends to decrease.

With regard to process Claims 5 and 6, what has been stated above with regard to the rejection over Aoki et al, applies herein as well, since Toyoguchi neither discloses nor suggests the process recited in these claims.

For all the above reasons, it is respectfully requested that the rejection over Toyoguchi be withdrawn.

The rejection of Claims 1, 2, 5-7, 10 and 11 under 35 U.S.C. § 102(e) as anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as obvious over, U.S. 6,395,426 (Imachi et al), is respectfully traversed.

Imachi et al disclose a non-aqueous electrolyte cell having a positive electrode with Ti-attached LiCoO_2 , wherein the mole ratio of the titanium and/or titanium compound to the lithium cobalt oxide is in the range of from 0.00001 to 0.02 (paragraph bridging columns 2 and 3), which material can be produced by mixing lithium cobalt oxide powder with titanium oxide powder and/or a metallic titanium powder, and thereafter baking the mixture (column 4, lines 43-56). Another method involves mixing powdered titanium-compound-mixed cobalt oxide with at least one lithium compound selected from the group consisting of lithium hydroxide, lithium carbonate, and lithium nitrate, and then baking the mixture (column 5, lines 1-18). Imachi et al thus produce their material differently from Applicants and thus, in view of the above-discussed comparative data, Imachi et al's material would appear to be different from that of the present claims. In addition, Imachi et al is available under 35

U.S.C. § 102(e) as of its filing date of October 28, 1999. **Submitted herewith** are certified English translations of two of Applicants' priority applications, i.e., JP11-287781 and JP11-287785, each filed October 8, 1999. The Examiner is requested to find that Applicants are entitled to the dates of these priority applications under 35 U.S.C. § 119. Accordingly, Imachi et al would be removed as prior art.

With regard to process Claims 5 and 6, what has been stated above with regard to the rejections over Aoki et al and over Toyoguchi, applies herein as well, since Imachi et al neither discloses nor suggests the process recited in these claims.

For all the above reasons, it is respectfully requested that the rejection over Imachi et al be withdrawn.

The rejection of Claims 1, 2 and 4-11 under 35 U.S.C. § 102(e) as anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as obvious over, U.S. 2002/0081495A (Nakajima et al) are respectfully traversed. Nakajima et al is **not** prior art herein. It is available under 35 U.S.C. § 102(e) as of its filing date of November 5, 2001. The present application, on the other hand, was filed as an international application on October 5, 2000, which is automatically the U.S. filing date according to statute, i.e., 35 U.S.C. § 363. Accordingly, it is respectfully requested that the rejection over Nakajima et al be withdrawn.

The rejections of Claim 4 under 35 U.S.C. § 103(a) as unpatentable over either of Aoki et al, Toyoguchi, or Imachi et al, in view of U.S. 5,709,969 (Yamahira), are respectfully traversed. The Examiner relies on Yamahira for a disclosure of volumetric density, and specifically one having a range of from 2.0 to 4.3 g/ml (paragraph bridging columns 3 and 4). In Yamahira, a mixture of a lithium compound and a cobalt compound is compression molded, and then sintered to prepare a sintered compact pellet, and this pellet is as itself used as a positive electrode for e.g. a coin-shaped cell. In Yamahira, the volumetric density of the

sintered compact pellet is from 2.0 to 4.3 g/ml. Accordingly, Yamahira is fundamentally different from the present invention in the method for producing the positive electrode material and the method for using the positive electrode material. In the present invention, a mixture is not pelletized and no sintered molded body is prepared. In the present invention, the press density of a sintered powder is defined. Nevertheless, even if the products of Aoki et al, Toyoguchi, or Imachi et al, were to have the volumetric density of Yamahira, the result would still not be the presently-claimed invention, because Yamahira does not remedy the above-discussed basic deficiencies of Aoki et al, Toyoguchi, and Imachi et al. Accordingly, it is respectfully requested that these rejections be withdrawn.

The rejections of Claims 8 and 9 under 35 U.S.C. § 103(a) as unpatentable over Toyoguchi or Imachi et al, each in view of U.S. 5,702,843 (Mitate et al), are respectfully traversed. The Examiner relies on Mitate et al for a disclosure of a current collector supporting an electrode. But even if a current collector were used in the cathode active material of Toyoguchi or Imachi et al, Mitate et al would still not remedy the basic deficiencies of these references, as discussed above. Accordingly, it is respectfully requested that these rejections be withdrawn.

The rejection of Claim 9 under 35 U.S.C. § 112, second paragraph, is respectfully traversed. Indeed, the rejection is now moot in view of the above-discussed amendment. Accordingly, it is respectfully requested that it be withdrawn.

The objection to the Abstract of the Disclosure is respectfully traversed. Indeed, it is now moot in view of the above-discussed amendment. Accordingly, it is respectfully requested that it be withdrawn.

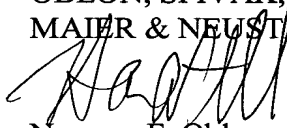
Regarding the discussion in paragraphs 7-9 under "Information Disclosure Statement," in the Office Action, the Examiner is reminded that according to the Notice

published in 1156 Off. Gaz. Pat. Office 91 (November 23, 1993), and MPEP 609 (8th ed., page 600-119), in PCT national stage applications, when the above Form PCT/DO/EO/903 indicates that both the International Search Report and copies of the references cited therein have been received by PTO, the Examiner **will** consider the references and should state for the record that the references have been considered. In view of such form of date May 30, 2002 in this application, **Applicants respectfully solicit the Examiner to consider these references and to explicitly state that for the record.** Thus, to the extent prior art described in the specification was cited in the International Search Report and not listed on a form PTO-892, it was error for the Examiner to not consider it.

All of the presently pending claims in this application are now believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

Respectfully submitted,

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Amendment Filed Herewith

IN THE CLAIMS

--9. (Twice Amended) The positive electrode for a lithium secondary cell according to Claim [7] 8, wherein the current collector is aluminum or stainless steel.

12-14. (New).--

IN THE ABSTRACT

(New).